BINGHAMTON UNIVERSITY
STATE UNIVERSITY OF NEW YORK

Thomas J. Watson School of Engineering and Applied Science

Watson Capstone Projects
Master Statement of Work

Computer, Electrical, and Mechanical Engineering
2017-2018 Version

Scope

In Watson Capstone Projects, we emphasize the program management Iron Triangle of Scope, Cost, and Schedule as students begin the transition to practicing engineer. This document describes the project expectations for sponsors, faculty advisors, industry mentors, client representatives, students, and course instructors participating in the Watson School's Computer, Electrical, and Mechanical Engineering senior design projects. The course syllabus covers academic issues, and is the higher-precedence document.

Through arrangements between course instructors, some Biomedical Engineering, Industrial Systems Engineering, General Engineering Minor, and Computer Systems students also participate in these projects.

This document tends to use industrial and contractual-type language for educational purposes. The reality is that our sponsors are supporting the students and their projects, with no assurance of successful projects or usable deliverables. Indeed, some of the best learning opportunities come from significant challenges, with not all completely overcome. This can also benefit the sponsors, especially those that include management of a capstone project as part of their own engineering leadership development program.

Desired Project Aspects

Projects should start at the beginning of the design cycle, as it is desired that students gain experience with problem definition, conceptual design, detailed design, fabrication and prototyping, and testing. Projects should also require the students to consider professional design concepts such as ergonomics, cost, manufacturability, tolerances, codes and standards, ethics, and product life cycle.

Intellectual Property

Our customary practice is for the students' work on these projects to be placed in the public domain.

Should a corporate partner share proprietary or competition sensitive information with us in the course of these projects, the University and Watson Capstone Projects course instructors will take reasonable precautions to keep it confidential and not divulge it to third parties unless required by law or legal process.

Publicity

The student projects and their sponsors will be publicized in Binghamton University media. Material produced by the student teams, such as a project experience video, will be subject to review by their project sponsors prior to submission by the students. Please contact a Watson Capstone Projects course instructor with any restrictions or concerns, and note them in the project proposal where possible.

Project Deliverables

Project results from student teams are very dependent on the nature of the project, team capabilities, degree of sponsor cooperation, and many other variables. Deliverables to sponsors and clients may take these forms:

- Engineering documents and drawings
- Prototype hardware, firmware, and software
- Presentations, videos, and demonstrations

Each project team will deliver at least the following engineering documents and presentations. Delivery requirements are specified in a Common Data Requirements List.

- Fall
    - Project Requirements
    - Conceptual Design Briefing
    - Design Report
    - Design Presentation
- Spring
    - Integration and Test Plan
    - System Verification Procedures

- Project Experience Video (internal to WCP)
- Project Report
- Project Presentation

Some projects will also deliver other documents pertinent to their project, such as prototype user guides, maintenance manuals, or software design reports.

Development Process

Each project team should execute the following development steps in sequence, with overlap permissible, in order to meet course deadlines and complete their project. Figure 1, a generic high-level project schedule, illustrates these development phases and related documents and presentations. The timing and sequencing of the steps may be varied to better suit the project, subject to approval of the team's Faculty Advisor and the Course Instructors. Note that where the term "project advisors" is used below, it means a team's Faculty Advisor, and if applicable, their Industry Mentor.

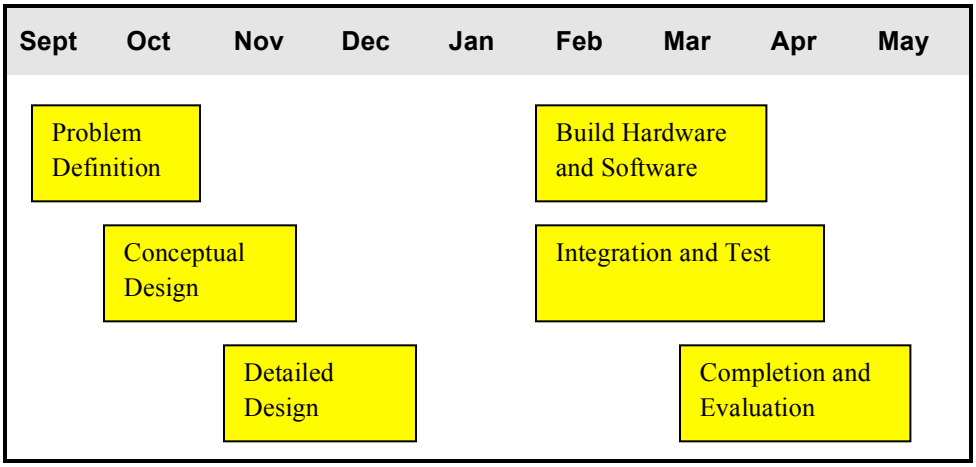

Figure 1 High-level Project Schedule

Problem Definition

Project teams begin their Problem Definition by meeting, as applicable, with their project sponsor, submitter, client, industry mentor, and faculty advisor. They then start their technical review of the project's problem domain and relevant technologies.

Teams must refine, restate, discover, and/or amplify the project requirements as necessary to ensure that they, their advisor(s), and instructors have a mutual understanding of the project's scope. This defines exactly what their project device must do for them to be able to declare success at the end of the spring semester. A context diagram shall be created that shows the environment in which the project "system" will operate. The Requirements Analysis effort

should explicitly define the system's external interfaces, and may produce some design constraint requirements, but should not include any actual design work.

During their problem definition effort, teams may negotiate their project's system requirements with their Faculty Advisor, and as applicable, their Industry Mentor and Client Representative. The results should be:

- Required features and attributes for the new project system that any reasonably competent and committed team should be able to accomplish.
- Stretch goals for the new project system that an exceptionally competent and committed team may be able to accomplish.

These requirements and diagram(s) are then gathered by the teams into Project Specifications for review and approval by their project advisors, and then submitted for grading.

Conceptual Design

Project teams next create conceptual designs by:

- Continuing their technical review of the project's relevant technologies,
- Brainstorming and producing potential design alternatives,
- Evaluating these alternative designs against their system requirements,
- Producing a system-level design with hardware, firmware, and software allocations,
- Creating a functional system block diagram, supplemented as appropriate by a physical layout drawing, a software architecture diagram, etc.,
- Defining the major hardware subassemblies or devices, firmware modules, and software modules,
- Defining, at an abstract level, all interfaces between the major subassemblies and upper-level modules,
- Establishing a project budget that allocates available funding to the major expense items and areas,
- Making informal hardware and software development environment plans, and
- Beginning modeling and simulation efforts, circuit breadboarding, and the like, in order to reduce risk in critical areas of the system design.

This design information is to be packaged into a Conceptual Design Briefing for presentation to and approval by the project advisors, and then submittal for grading.

Detailed Design

The teams finish the design process by:

- Completing modeling and simulation efforts, circuit breadboarding, and the like,
- Making parts lists and procurement plans,
- Drafting hardware drawings,
- Creating electrical schematics, printed circuit board layouts, and wiring diagrams,
- Writing pseudo code for software and firmware modules,
- Planning efforts required for completion, with tasks allocated to individual team members in a detailed schedule for the rest of the project, and
- Meeting with a Watson School technician for a Design Makeability Review.

This detailed design information, along with a summary of the problem definition and a description of the conceptual design, is to be packaged into a Design Report for review and approval by the project advisors, and then submittal for grading. A Design Presentation that summarizes and illustrates this information is to be presented for review and critique by the project advisors, and then presented to a review panel for grading.

Building Hardware and Software

Teams create their project's lower-level hardware and software units by:

- Buying components, machine stock, etc.,
- Machining and 3D printing parts,
- Coding firmware and software modules, and
- Testing those units individually.

The unit test requirements may be system-level requirements allocated to individual units, or requirements derived from the system design.

Integration and Test

Teams are to first develop a plan for their Integration and Test effort, for review and approval by the project advisors, and then submittal for grading. As applicable to their project, teams will integrate their system into subassemblies and then into a complete system, testing each increment as they proceed.

They will also write detailed procedures for their system verification tests that are to prove their system meets all its requirements. These System Verification Procedures are likewise given to their project advisors for review and approval, and then submitted for grading. When the project system is completely built and working, teams "dry run" their system verification tests, making corrections to the system as necessary.

Teams with projects to be installed at a client facility must pass an Installation Readiness Review with a Watson School technician, along with a client representative if available, prior to installation.

Final Tests and Conclusions

Teams complete their projects by:

- Performing their system verification testing for their Faculty Advisor,
- Performing system verification testing for their Industry Mentor and Client Representative (if applicable),
- Delivering the project system to a Sponsor or Client (if applicable), and
- Documenting
    - The system build process,
    - Any design modifications made during build, integration, and test efforts, and
    - The results of the system acceptance testing,
- Disposing of any residual project assets as directed by their Sponsor, Client, or the Course Instructors.

This information, along with an updated version of that in the Design Report, is to be packaged into a final Project Report for review and approval by the project advisors, and then submittal for grading. A final Project Presentation that summarizes and illustrates this information is to be presented for review and critique by the project advisors, and then presented to a review panel for grading.

Responsibilities

Industry Mentor and Client Representative Responsibilities

The most critical factors to a successful project are communication and commitment. A successful capstone project requires that the sponsoring organization assign a motivated individual to oversee and interact with the students throughout the project duration. An hour a week is sufficient on a typical project. This sponsor‘s Industry Mentor and the Client Representatives asked to do the following:

1. Provide more detailed information for the team beyond the initial project proposal.
2. Facilitate visits by the students to the sponsor's and client’s locations. One or two visits by the students to the sponsor site during the project are typical; many more are expected at the client’s location.

3. Meet with the students regularly (at least twice a month, either at the sponsor's and/or client's site, at Binghamton University, or via telecommunication).
4. Review documents to provide feedback from a customer's point of view (e.g., progress reports, project proposal, design analysis, design guide, etc.).
5. Evaluate the students' individual performances and provide feedback to their faculty advisor.
6. Demand professionalism and a high level of performance from the students.
7. Attend the project presentations during the last week of the Fall and Spring semesters.
8. Supply any necessary physical resources that are not already available at the university. Should additional resources or equipment be needed to complete the project, students are expected to justify them by written proposal to the sponsor.

Student Responsibilities

Each student team is tasked with these main responsibilities to their sponsors:

1. Visit the project sponsors and clients (as applicable) at their locations, and meet with them regularly (see above). Consider them the project's customer; if the project has no Industry Mentor or Client Representative, the Faculty Advisor will act as the project customer.
2. Provide periodic status presentations to the project sponsor and client (if applicable).
3. Provide approximately one workday of effort on the project by each team member each week.
4. Gather more detailed information about the project requirements, reach agreements and make commitments with the project sponsors, develop a project plan, work to that plan, maintain good customer communications, meet those commitments, and deliver a product and other deliverables that meets the requirements.
5. Avoid disclosing the sponsor's proprietary or competition sensitive information, and refrain from using the sponsor's trademarks and logos without their sponsor's permission.
6. Provide a report about the project during the penultimate week of the Fall and Spring semesters.
7. Provide a presentation about the project during the last week of the Fall and Spring semesters.

The student teams will also provide weekly individual status reports to their faculty advisor and course instructors, and weekly team status presentations to their faculty advisor.

Faculty Advisor Responsibilities

Each team will have a faculty advisor, who acts a mentor to the project team in weekly meetings, critiques the team's work products, and evaluates the students' individual performances.

Course Instructor Responsibilities

The course instructors act as the program directors, being responsible for soliciting and selecting projects, assigning teams to projects, allocating and arranging for university resources needed by projects, and overseeing project and student evaluations.